

Appendix D

Road Hazard Inventory

Background

The most common sources of sediment in rural and forested areas are from unsurfaced roads. Monitoring source areas of sediment can identify inputs of sediment to the stream system that may need to be mitigated. Ideally this should be done on a watershed scale, because other sources of sediment are also present in the watershed. This protocol only addresses road-related sources of sediment.

Erosion associated with roads and ditches typically includes both surface erosion and landslides. Road construction disturbs and compacts soils and prevents revegetation. Therefore, in the forested landscape, roads are the greatest potential source of sediment outside the stream channels. This can occur in the form of surface erosion or landsliding.

Past monitoring indicates three major areas of concern for road-related erosion. One concern is excess spacing of cross drainage on steep gradient roads. Another is a side ditch routed over long distances with direct discharge into

channels. Finally, road-related landslides are typically associated with steep sidecast material. The three major elements (Table D-1) of the road hazard inventory address these road concerns.

Table D-1. Elements of road hazard inventory

Inventory Elements	Area of concern
Stream crossing structures	Washouts of crossings and fish passage through culverts
Sidecast fill on steep slopes	Sidecast-related landslides entering channels
Road surface drainage systems	Muddy drainage waters delivered to streams

In order to use this protocol, several terms need to be understood by monitoring participants:

Road prism

Cross section of roadway from the top of the excavated area (cut) to the toe of the fill.

Cutslope

Slope created by excavation into the natural hillslope. The cutslope is steeper than the natural slope.

Sidecast

Unconsolidated excavated material pushed to the slope below the road. Sidecasts are generally not used as part of the road and are steeper than the natural slope.

Fillslope

Excavated material placed below the road and intended to serve as part of the road.

Inslope

Road surface that is sloped so that all water drains toward the ditch or cutslope.

Outslope

Road surface that is sloped so that all water drains toward the fillslope or sidecast.

Berm

A continuous pile of fill and/or aggregate, usually on the outside edge of a road which prevents surface water from leaving the road.

Cross drain culvert

A culvert installed under and across a road to carry ditch water to the downslope side of a road..

Stream crossing culvert

A culvert installed in a stream channel intended to carry stream flow under the road.

Bridge

A structure intended to carry vehicles over a stream or other feature, usually consisting of a span and abutments.

Log puncheon

A drainage structure made of logs (often cedar) and no longer in common use.

Ford

A stream crossing where stream flow covers the crossing for all or part of the year.

Waterbar

A constructed ditch and berm designed to direct water across the road.

Dips

A cross drainage structure where a low spot is excavated along the profile of the road and where surface water of stream flow is directed across the road.

Grade break

Location where the road grade reverses (typically on a saddle or ridge) and surface water automatically drains away from the road surface in question.

Ditch

Trench constructed at the toe of a cutslope and intended to keep water off the road surface. Ditch water is drained down slope along the road to some point of relief or cross drain.

Landing

An area constructed for logging equipment and log handling operations. Landings may be at the end of roads, or constructed as wide spots in the road. They are typically wider than the rest of the logging road.

Ridge Road

Ridge roads are located on or near the ridgeline (most or all of the road on the top one-third of the slope).

Midslope Road

A road located between a ridge and stream channel

Valley Road

Any road which generally parallels a stream in places, usually in the former riparian area of the stream.

Equipment Needs

In order to successfully and efficiently collect road data, the following equipment is needed:

- Vehicle—a vehicle (pick-up or utility rig) is preferred for road access, although a mountain bike can also be used where access is poor.
- Two person crew—a single person can collect the necessary data, although a crew of two can be more effective. The inventory person or crew

can also be used to mark culverts and to flag locations needing immediate maintenance attention.

- Distance Measuring Instrument (DMI) and Hip Chain (String Box)—a DMI or other device that records vehicle travel distance in feet is recommended to accurately record distances while traveling along roads. Impassable roads are measured with a hip chain (string box).
- Clinometer—a clinometer is used to determine average road gradient and hillslope steepness. More accurate measurement tools (engineer's level) are required for any actual repair activity.
- Scaled rod or staff and a measuring (loggers) tape—lengths of culverts and bridges will be measured with these tools.
- ODF stream classification maps—on USGS 7.5 minute quad maps and/or other maps showing roads and streams are also needed.
- Global Positioning System (GPS)—GPS may be used to map road features. However, use of GPS to date has significantly slowed data collection, and is not an essential component of this protocol. GPS efficiency is poor in areas of narrow canyons or when the canopy is wet.
- Data Logger—direct data entry into a field data-logger as it is being collected can be very efficient.
- Computer System and Software—inventory information should be entered into relational databases. Relational databases are probably the most effective tool for making sense of large amounts of information. Commonly available software can be used to query the database to find high erosion hazards or barriers to fish migration.
- Geographic Information System (GIS)—data can be entered into a GIS system without GPS data using *dynamic segmentation*. If GPS has been used, the locations of features can be directly input to a GIS system.

Site Selection

The road hazard inventory is designed to assess all roads under a given ownership or within a given watershed. The protocol provides information to help landowners identify roads of concern and prioritize repair activities. It does not provide all the information necessary to implement those repairs. Timely inspection and subsequent maintenance or

repair activity on forest roads will benefit fish and fish habitat. Therefore, inventories should eventually be conducted on all road miles that potentially affect fish habitat.

Prioritizing site selection depends on the monitoring question being asked. However, in general, road inventories should first be conducted in areas where roads pose higher risk to anadromous fish and their habitats. This can be determined from:

- Landowner knowledge
- Topographic maps showing:
 - stream crossings of fish bearing streams,
 - midslope roads on steep slopes, and/or
 - steep, long road grades leading to channel crossing

Landowners are encouraged to use this protocol for road management purposes other than erosion hazard reduction. Possible uses include routine maintenance and surfacing decisions.

Road Hazard Field Methods

Overall Methodology

Begin at a road junction or other landmark. Take measurements described in the **Surface Drainage Section** below. As you travel along the road, measure the distance (DMI or other device starting at 0), until encountering a drainage feature and or stream crossing. This is referred to as road stationing. Record distance traveled, repeat surface drainage measurements and take **Culvert/Bridge and/or Stream Crossing Details** (described below), whichever are applicable. Record observations of general road characteristics (described in next section) for the entire road.

General Road Characteristics

Each road should be identified by name or number, according to the system normally used by the landowner. General characteristics are normally collected only once for each road. The following observations are used to classify each road and can be documented on a form such as in Table D-2:

Road identification by name, numbering system or other means.

Road use by management activity.

active roads: roads used for timber haul in the past year

inactive roads: include all other roads used for management since 1972; and

orphaned roads: overgrown roads or railroad grades not used since 1972.

Surfacing material is described as asphalt, clean rock (new quarry rock); old rock (more common); or dirt.

Road location is described as ridge, midslope, or valley as the location of most of the road.

Width of the entire road is estimated (from the outside edge to the base of the cutslope).

For ownerships where *georegion, geology or soils* are variable and have a great influence on erosion, these classifications should also be documented.

Record whether the road is *outsloped* or has a *ditch*.

Record the *location* of the road with respect to a landmark. This may be done with the GPS unit or on a map.

Surface Drainage

Between drainage features, information is collected on the erosion potential and sediment delivery potential of the roadway. The typical road conditions between each drainage feature are categorized to identify erosion problems. The following observations and measurements are made to identify symptoms of high erosion on road segments that best describe the condition of the entire segment:

Road Grade

Road grade (slope) is measured in percent, with an estimated average when the slope changes. Slope is recorded as positive if the direction is up from the measuring point or feature, and negative when the direction is down from the feature. A positive slope drains toward the feature, a negative slope drains away from the feature.

Road Surface Condition

Road surface condition is described as good, rutted, bermed, or eroded (gullied).

Ditch

Ditch is described by function as good (capable of holding runoff without serious erosion), cutting, diverted, or full.

Cutslope

Cutslope is described as good (stable), ravel problems, or slides into the road.

Delivery

Delivery of sediment to streams from that length of road is described as “yes,” “possible,” “no,” or “bypassed” (water flows past the drainage feature and not off of the road).

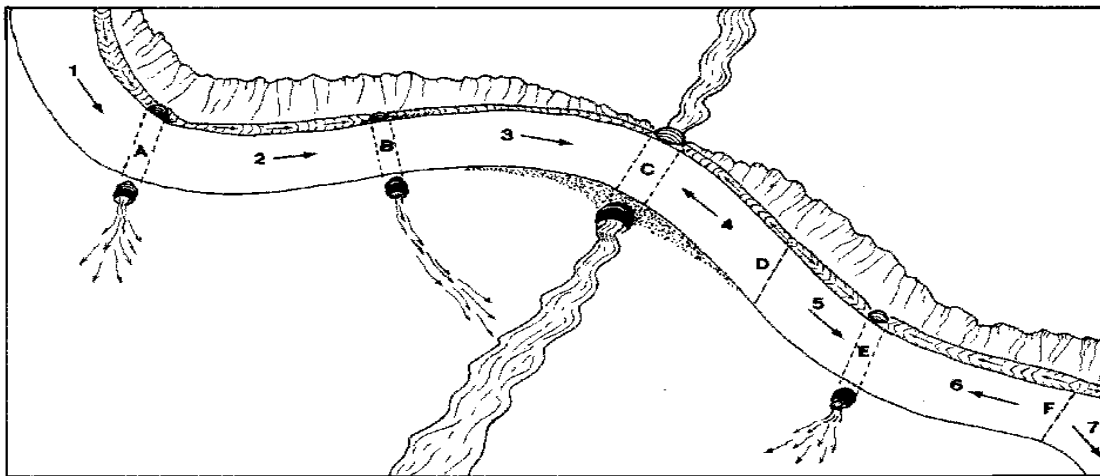
Road length draining to drainage.

The length of road draining to each drainage feature can be calculated by use of several commonly available database or spreadsheet programs. For properly functioning outsloped roads there are no cross drainage features, only stream crossing features.

Drainage and Stream Crossings

Drainage data is collected at each drainage feature where collected drainage water is directed away from or under the roadway, and also at drainage divides. Drainage features include: stream crossing culverts, bridges, log puncheons, fords, cross-drain culverts, waterbars, dips, other relief, landings, and grade breaks. For each drainage feature, record the distance from road stationing and the type of feature so that drainage spacing can be determined.

Landowners may also choose to locate features such as gates and water pump chances. A typical length of road with drainage patterns and features is shown in Figure D-1.



- A. Cross-drain culvert, sediment filtered and not delivered to stream.
- B. Cross-drain culvert with sediment delivery from segment 2 to stream.
- C. Stream-crossing culvert, sediment from road segments 3 and 4 delivered to stream.
- D. Drainage divide.
- E. Cross-drain culvert, possible sediment delivery to stream.

Figure D-1. Typical road surface drainage and drainage features.

Culvert (and bridge) Detail

The following information is collected for all culverts (stream crossing and cross drain) and bridges:

Diameter/Span

Diameter/span of the culvert (diameter for round, rise and span for arch) or span length (for bridge) is measured in inches (for culverts) and feet (for bridges).

Condition

Condition of the culvert is described as good; mechanical damage, sediment blockage, rusted, bottom out, collapse, animal (beavers), wood

blockage, natural bottom (gravel) [more than one description may be appropriate in this category].

Inlet Opening

Inlet opening is estimated as a percent or original (design) opening.

Stream Crossing Detail

Stream crossings are an extremely important part of the road system. Improperly functioning stream crossings can result in loss of the roadway through washouts and channel diversions. Stream crossings can also be barriers to fish movement. At each crossing structure, information should be collected by getting out of the vehicle and taking measurements at

the inlet end and near the outlet end of the structure. In addition to the culvert detail, the following

information should be collected at each stream-crossing culvert (Figure D-2).

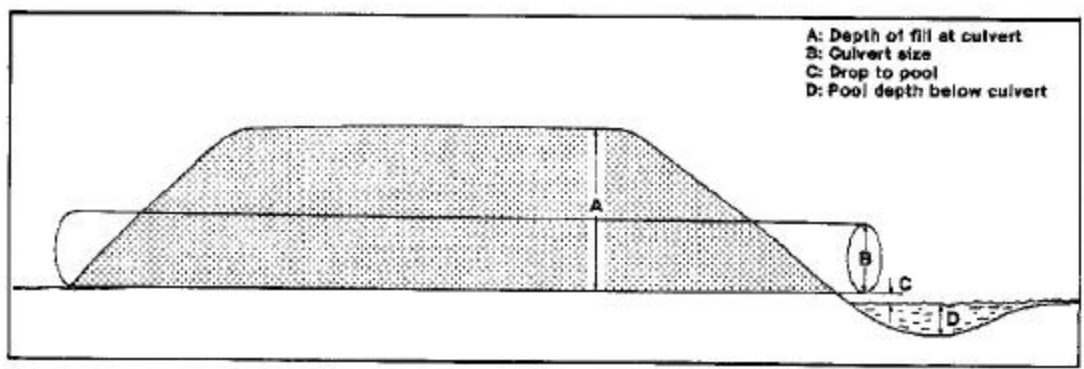


Figure D-2. Stream-crossing culvert with key dimensions.

Fish Presence

Fish presence (species, if known, from ODF classification maps or other sources). Categories are: “fish use”; “unknown fish use”; “no fish use”; or “anadromous fish use”.

Diversion Potential

Diversion potential (for streamflow diverted onto the road surface and eroding the roadway or fill) is categorized as “high,” “medium” or “low.”

Culvert Slope

Culvert slope is measured for “fish use,” or “unknown fish use” streams only.

Fill Height

Fill height is estimated from the channel bottom to the road surface at the downstream end.

Outlet Drop

Outlet drop is the distance from the bottom of the pipe to the elevation of the pool, in feet (measure countersunk outlets as negative drops). This can vary with stream discharge, so measurement should generally be taken during summer flow.

Resting Pool

Resting Pool below the pipe is categorized for fish use, or possible fish use streams only as “good” (at least two feet deep and six feet long); “fair” (at least one foot deep and four feet long); or “absent.”

Sediment Filtering

Sediment filtering opportunities around the crossing are noted as “utilized,” “not utilized,” or “not available.”

Sidecast Detail

Sidecast-related landslides are reasonably expected along particularly steep sections of road (Table D-3). Depending on georegion, geology, soil, and drainage, the natural slopes (below the road) for a steep section can be as gentle as 50% (in wet areas with weak sidecast and drainage problems). In areas with well-drained materials with uniform slopes and no or very limited signs of old slides, the appropriate slope may be 65 or 70%. Sections of road which have experienced past sidecast-related landslides should also be inventoried.

The beginning and ending points used to characterize sidecast stability will be different than those used to characterize drainage. Therefore, a separate database is used (Table D-3).

Begin characterizing sidecast stability at the point in the road where steepness indicates a slope failure hazard exists. This may be, and usually is, at some distance between drainage features. Record this station distance from the road junction or landmark using the same stationing methods as recording from drainage features. Also record the ending point in the same manner. The following features are then used to describe typical conditions over the steep sections:

Average Natural Slope Steepness

Average natural slope steepness under the sidecast (if present).

Indicators of Movement

Indicators of movement described as “none,” “cracks,” a “drop in the outside of the prism,” or “signs of old sidecast slides.”

Vegetation

Vegetation on the sidecast is described as “none,” “cover (grass or brush),” “reproduction (plantation),” or “forest.”

Fill Condition

Fill condition is described as “at least 15% steeper than the natural slope,” “logs exposed,” or “good.”

Fill Depth

Fill depth at the outside edge of the road is estimated to the nearest foot as a vertical measurement.

Downslope Risk

Downslope risk to streams is described by a qualitative rating of the slope to the nearest stream channel: “low,” “moderate,” or “high” based on the presence and size of benches or landings between the site and the nearest channel.

Forms

Example data sheets suitable for relational databases are shown in Tables F-2 and F-3. One data sheet has been designed for surface drainage and stream crossings (Table D-2), and another data sheet for sidecast (Table D-3), since the beginning and ending points of areas of sidecast rarely coincide with drainage location. Codes for the data sheet are explained on the pages following the data sheets. The codes have been designed with one or two digits (underlined) to reduce the size of the code sheets.

Table D-2. Field data sheet for surface drainage and stream crossing details and examples of collected data. In this example attention is required on the last entry because the culvert is partially blocked.

Surfacing: Dirt, Rock, Clean rock

Ditch: yes/No Outslope: Yes/no

Geology/Soils _____

[illegible]

SC = stream crossing culvert CC = cross drain culvert BR = bridge JN = road junction GB = grade break PN = log puncheon

DR = any other ditch relief
PC = pump chance

I = features requiring immediate attention
G = gate

WB = waterbar

DP = dip

LD = landing

Table D-3. Field data sheets for sidecast details. Example included.

Road name/Number: _____ Date _____

Inventoried by _____

Sidecast Detail								
Station Start (ft)	Station end (ft)	% slope Below	Movement Indicators.	Vegetation	Fill condition	Fill depth	Downslope Risk	Remarks
3413	3814	70	S	F	C	2	H	Stream has washed out road.

Codes:	Codes:	Codes	Codes:
Cracks	None	Steep 15	Low
Drop	Veg.	Logs	Moderate
Slide Activity	Reprod.	Good	High
None	Forested		

Road Data Analysis

Road data should be analyzed to determine which roads, drainage systems, and/or stream crossings:

- are not functioning properly,
- may be delivering sediment to fish-bearing streams,
- do not pass fish (calculated from the data collected, refer to ODF&W fish passage protocol),
- and/or pose a risk to fish bearing streams (road-related landslides).

A number of indicators for potential sediment problems may exist. Examples include:

- Average distance to first cross drain is over 500 feet and road grade is greater than 6%;
- Culverts that are more than 50% blocked;
- Logs in fills;

- Steep sidecast with high downslope risk;
- Fish bearing streams with culverts that have a >0 foot outlet drop, gradient over 1% and are not retaining sediment or do not have baffles.

Calculations of the road data can be done with a spreadsheet or database to address these road maintenance, sediment, and fish-passage related concerns.

Road-related results can be combined with turbidity and channel information to understand erosion and sediment processes in your watershed. It is important to recognize that a correlation between the three measurements may not reflect cause-and-effect relationships. In general such relationships can only be achieved with a properly designed and controlled study. However, over time the data will be useful for understanding environmental trends.

